INSTRUCTION MANUAL

NO. 6407A

BARBER COLMAN

Capacitrols

model 407P

BARBER-COLMAN COMPANY
Industrial Instruments Division • Rockford, Ill., U.S.A.

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NOTE: This instruction manual to be given to persons responsible for installation and maintenance of this instrument.

UNPACKING INSTRUMENT

This precision instrument and its associated equipment have been carefully manufactured and packed at the factory. Remove the instrument and accessories from the packing box and check items against the packing slip. If the equipment is found to be damaged in transit, report extent of damage to the carrier immediately. Repack in original packing box until ready for installation.

CAUTION:

Handle with care.
Safeguard instrument from shock.
Avoid oil accumulation.
Keep instrument temperature under 130° F.

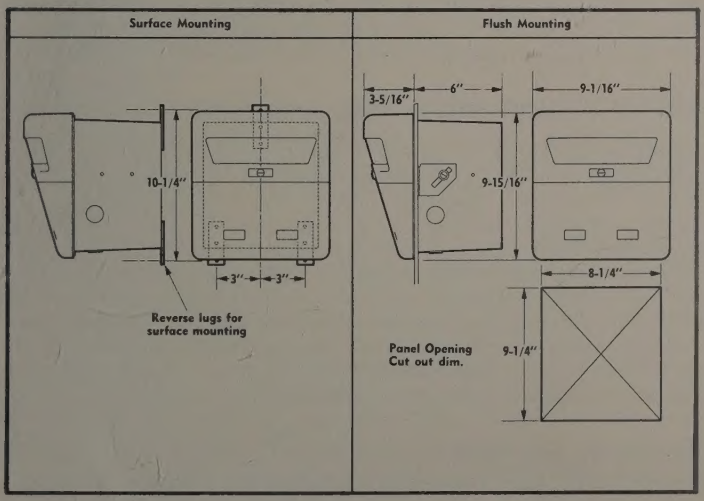
MOUNTING INSTRUCTIONS

Locate the instrument to avoid shock, excessive vibration, moisture and temperatures over 130° F. Avoid furnace walls, radiation of heat, machine frames and outside walls. Provide suitable shelter to avoid moisture and temperature extremes if installed outdoors.

For surface mounting, reverse the three lugs on the back of the instrument housing. See the mounting surface mounting dimension drawing.

For flush or panel mounting, remove the brackets on either side of the instrument housing, insert the instrument through the panel opening, replace the brackets and tighten firmly. See the flush mounting dimension drawing.

MOUNTING DIMENSIONS



MOUNTING DIMENSIONS

Model 407P Vibration Mountings

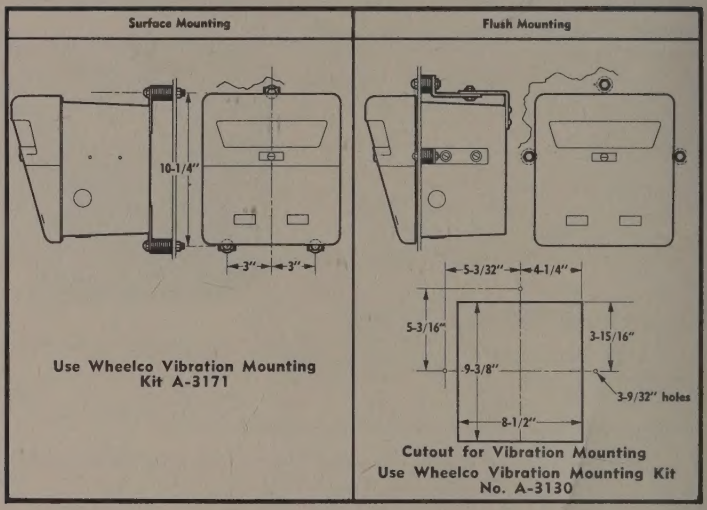


Fig. 3

The magnetic pilot is mounted in an upright position. If the small voltage indicating meter is mounted externally, the pilot may be mounted in any position. It is recommended that the pilot be located away from excessive vibration and heat. The ambient temperature should not exceed 130° F.

POWER WIRING MODEL 407P AND PILOT

Before connecting power to this instrument, check the supply voltage and frequency with the nameplate ratings on the control chassis. The supply voltage and frequency data is found on the chassis front. Connect supply to L1 and L2. Run all wiring in rigid conduit, Bx or Greenfield in accordance with the recommended electrical code. Tighten the binding screws on the instrument terminal board to secure the wires permanently. No. 14 gauge solid wire is recommended for wiring to instrument, between instrument and pilot amplifier, and between pilot amplifier and reactor. If stranded wire is used, tin ends to provide secure terminal connections. Be certain that the wires are placed away from moving parts of relay and housing gaskets.

Do not run thermocouple leads with any power or control wiring.

To alter the control chassis in the field for different line voltages, change the transformer primary connections in the chassis per following:

240 volt Solder red wire to chassis pin 10, (L2) green-yellow wire to chassis pin 12, (L1). Solder red-white wire to green wire and tape connection.

208 volt Same as above except solder green-red wire to chassis pin 12 (L1) and attach solderless wire connector to free end of the 240 volt tap.

120 volt Solder red and green wires to chassis pin 10, (L2). Solder red-white and green-yellow wires to chassis pin 12, (L1). See internal wiring diagram page 13.

REACTOR WIRING

In the event that the external control circuit of the reactor should accidentally open while the reactor is under load, an extremely high voltage could be induced in the control winding. This could damage the internal insulation as well as being a safety hazard. It is recommended that a shunting resistor be connected directly at the reactor terminals. This resistor is supplied connected to X1 and X2 of the reactor control windings.

The load circuit of the reactor is connected in accordance with manufacturer's instructions accompanying the equipment, however, figures 5 and 6 show typical wiring schemes for single and three phase applications.

The small meter in the pilot amplifier can be used to approximate the percentage of total reactor load, the 100 reading being equal to maximum power reactor output. When the equipment is powered, the small meter will not read down to zero with minimum reactor output, as the reactor does not completely cut load voltage to zero.

MEASURING CIRCUIT SPECIFICATION MODEL 407P

The Model 407P instrument is a thermocouple type instrument using as standard calibrations: Iron-Constantan, Chromel-Alumel and 13% Platinum-Platinum Rhodium. Check the data found on the instrument scale as to T.C. type, instrument serial number and total external lead resistance.

The measuring circuit system is normally designed for an external resistance of 15 ohms (check scale). 15 ohms is usually ample resistance for most lead wire runs. Find resistance of lead wire and subtract from specified external resistance as found on scale. The remaining resistance must be inserted internally by means of a removable resistance strip found in the chassis compartment. This compensating resistor strip is furnished on all original installations. Other values can be obtained from Wheelco at a nominal cost.

Connect proper type lead wire to the T. C. terminals according to the proper polarity signs. Negative wire always coded red. Polarity should

be rechecked when possible by heating a temporary junction of the lead wire far end with a match flame if such flame is not hazardous. Proper polarity connections will be indicated if the instrument travels upscale.

REMOVE THE JUMPER WIRE BETWEEN TERMINALS "S" AND T.C.—

This wire is used to short out the meter movement for shipping purposes only and should be replaced when shipping the instrument to prevent damage to meter. Avoid placing wires in the chassis compartment that may interfere with the relay or gasketed door.

TCB WIRING

The Model 407P is furnished with thermocouple burnout safety feature (TCB). Essentially it is a voltage that can be wired into the thermocouple circuit to drive the movement upscale in case of an open circuit in thermocouple, thus passing the limit or control point and causing the fuel flow to be shut off. The low resistance of the couple shorts the impressed TCB voltage down to an extremely low value and the TCB compensation is small. If the couple should open circuit for any reason, the TCB voltage is then impressed across the high resistance of the meter movement driving the meter indicator upscale. Do not connect TCB when instrument is used in conjunction with Heat Eye (radiation calibrations).

The TCB can be wired in two different manners:

(1) If lead lines are short, it is permissible to wire the TCB directly to the TC terminals.

(2) In case of long lead wires, copper wires should be run from the TCB terminals to the thermocouple head and connected + to + and — to —. Long lead lines will develop large voltage drops, if wired in first example above and necessitate large TCB corrections.

To check proper operation:

(A) Disconnect the thermocouple from the head, simulating an open circuit.

(B) With the control index previously set above normal operating point, the temperature indicator should swing above the control set point and reduce heat input to a minimum.

FINAL CALIBRATION

With TCB connected, thermocouple and wiring complete:

(1) Short out the thermocouple at the thermocouple head with piece of copper wire.

(2) Adjust the zero adjustment screw as found on top of front plastic cover until the indicated temperature agrees with the cold junction temperature as read on a glass thermometer placed at the thermocouple block terminals.

(3) Adjust to exact thermocouple head temperature—not to scale zero. This procedure compensates for TCB effect. An alternate method is to:

(A) Disconnect line from instrument.

(B) Short out the T. C. terminals in the instrument with TCB connected.

(C) Set indicated temperature, as above, to agree with temperature as read on glass thermometer at the T.C. terminals.

(D) Remove TC terminal shorting wire used in (B) above.

(E) Power instrument and note upscale deflection above that set in (C) above.

(F) Subtract the amount of upscale deflection; by lowering the temperature pointer the amount noted in (E) above by rotating the zero adjustment screw.

(4) Note the use of the mirror on scale to avoid errors in readings due to parallax.

(5) For complete scale calibration checking procedure, ask for Wheelco Instruction Sheet No. F-6434-1.

CONTROL SPECIFICATION MODEL 407P

The Model 407P instrument is always used in conjunction with a magnetic pilot which, in turn, drives a reactor.

The output of the Model 407P instrument varies, according to flag position, between 6 and 90 volts DC. This voltage, when connected to a magnetic pilot, produces a direct current output to control the reactor. The reactor is essentially a large choke coil with a superimposed DC control winding. Briefly, the direct current field effectively prevents the AC field from producing a reverse E.M.F. each cycle and allows AC current to flow. The amount of current flow in this load winding is proportional to the DC current flow in the control winding. Thus, on failure of control units or control supply voltage, the power output of the reactor to the load is reduced to minimum.

The magnetic pilot amplifies the DC output of the 407P instrument into a DC signal capable of delivering high amperage needed to saturate the reactor. (Refer to magnetic pilot instruction booklet for internal wiring and control specifications.) Properly sized saturable core reactors, when connected to an electrical load, will have a maximum voltage output of 90% or more of rated line voltage and controllable to a minimum of 3% of rated power.

DESCRIPTION OF ELECTRONIC CIRCUIT

The Model 407P is a modification of the basic "400" Series control family. The familiar Electronic Link principle is incorporated here to sense the position of the meter pointer in respect to the control set point. The "400" Series employs the simple tuned grid, tuned cathode oscillator as a means of obtaining correct amplifier voltage output.

Figures 5 and 6 show typical wiring connections commonly used. Always refer to manufacturer's instructions accompanying reactor.

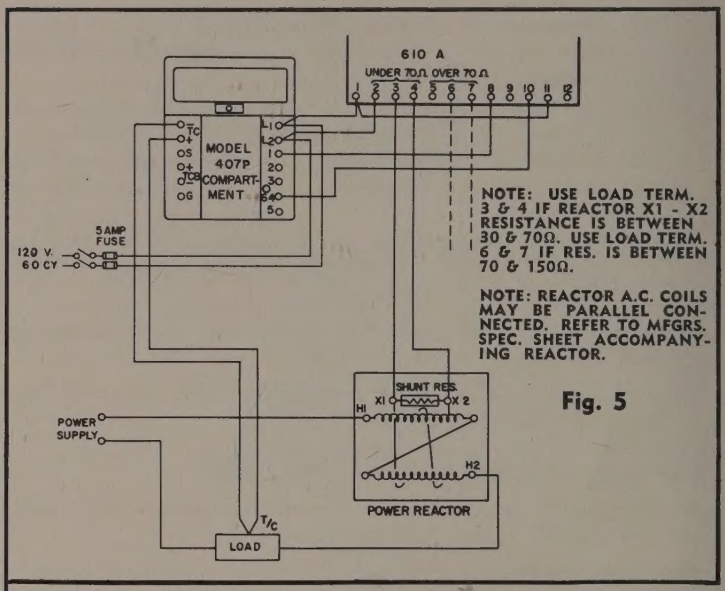


Fig. 5

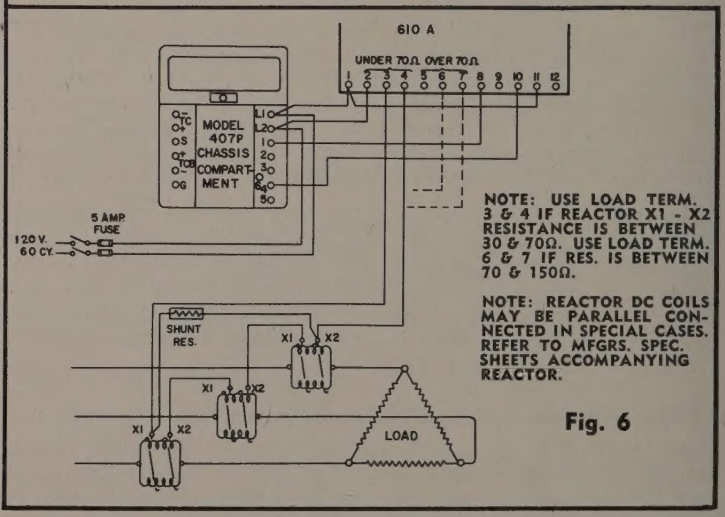


Fig. 6

When the vane carried by the temperature pointer passes upscale between the pickup coils mounted on the set point control segment, the circuit goes into oscillation and prevents the tube from conducting, decreasing the amplifier voltage output. This action causes the reactor to desaturate, decreasing the power to the load.

The amplifier output is controlled between 6 volts, minimum output, to 90 volts, maximum output, depending on flag position and proportional band adjustment. This voltage is conveniently measured at the red and black twin jacks on top of the plug-in chassis. (Red +, Black —). Note: Use a volt meter of 10,000 ohm per volt sensitivity or better.

The control chassis is designed to "plug-in" to the instrument compartment providing excellent servicing arrangement or for changing to other modes of control as provided in the "400" Series.

The control point setting knob is located directly beneath the instrument scale and is easily adjustable but protected against accidental shifting. The model number will be found on the control point set knob.

The green signal lamp is powered from the transformer secondary and indicates power on the chassis.

MANUAL RESET

The re-alignment of the meter pointer with the set pointer is readily adjustable by positioning of the tuning condenser on the control chassis. Using a small screwdriver, turn clockwise to lower the point of control and counter clockwise to raise the point of control.

PROPORTIONAL CONTROL

The proportional control band (throttling range) is conveniently adjusted by positioning of the "PROP. BAND" dial on the left side of the chassis front. The band is narrowed by turning the dial clockwise and widened when rotated counter clockwise. The proportional band is fully adjustable between .5 and 5.0% of meter span.

PROCESS CONTROL APPLICATION MODEL 407P

While the Model 407P instrument can be universally applied with the proper pilot amplifier to any size power reactor, it is important that the power reactor be sized to the load impedance. This is important in order to maintain design turn-down ratio. If the load resistance is increased (load wattage decreased) the lower control limit of voltage will be substantially increased. If the load resistance is reduced (load wattage increased), the maximum voltage output will be substantially decreased.

PILOT AMPLIFIER SPECIFICATIONS

The pilot amplifier is essentially a magnetic amplifier utilizing a small saturable core reactor and dry rectifiers to provide a controllable dc current which is used to saturate the power reactor control winding.

Several models are currently available:

Model 610A, line voltage 120v 60c; output, 5-75 volts dc, maximum power 188 v.a. on reactor windings. Reactor capacity 0-30 KVA.

Model 611A, line voltage 120v 60c; output, 4-75 volts dc, maximum power 250 v.a. on reactor windings. Reactor capacity 30-80 KVA.

Model 611B, line voltage 240v 60c; output, 8-150 volts dc, maximum power 250 v.a. on reactor windings. Reactor capacity 30-80 KVA.

Model 613A, line voltage 240v 60c; output, 8-150 volts dc, maximum power 500 v.a. on reactor windings. Reactor capacity 80-200 KVA.

Note: The Model 613A pilot is always driven by a Model 610A. One 610A pilot will drive three Model 613A pilots to give reactor capacity to 600 KVA on three phase systems.

INITIAL CONTROL START-UP ADJUSTMENTS

When the wiring has been properly completed and the equipment is ready to start, turn on the power. Adjust the "PROP. BAND" knob (proportional band width) to middle position. Set the red control set pointer so that it is directly in line or in coincidence with the black indicator. Observing the small meter on the pilot amplifier, adjust the RESET so the small meter reads approximately at midscale or 50. As the temperature may be changing while adjusting, recheck coincidence of the red and black pointers of the Model 407P.

After the temperature is leveled off at a steady value, note the position of the temperature in relation to the control set pointer. Rotate the "Man. Reset Adj." clockwise to lower and counter clockwise to raise the controlled temperature, to align the two pointers. Upon observing temperature deviations due to load changes, slowly turn the "PROP. BAND" adjustment clockwise to obtain cycling. Back off counter clockwise until cycling is no longer present. This point will depend upon furnace capacities and heat rates and must be determined for each individual installation. The throttling range band is adjustable between approximately ½ and 5% of scale. Note: The "Man. Reset" may need to be repositioned slightly to realign the temperature pointer with the control point after the optimum "PROP. BAND" position has been set.

MODEL 407P
MAINTENANCE AND SERVICE CHECKS

While the 407P Series instrument is well designed and manufactured of high grade components, it is worthwhile to have information as to service and spare parts for emergency servicing. Where a number of instruments are located together, the plug-in parts are interchangeable and allows a minimum inventory.

Upon experiencing a trouble complaint, the serviceman should familiarize himself with the process and instrument application to ascertain the exact function of the instrument as applied. The instrument trouble usually can be traced to two basic problems, measurement or control.

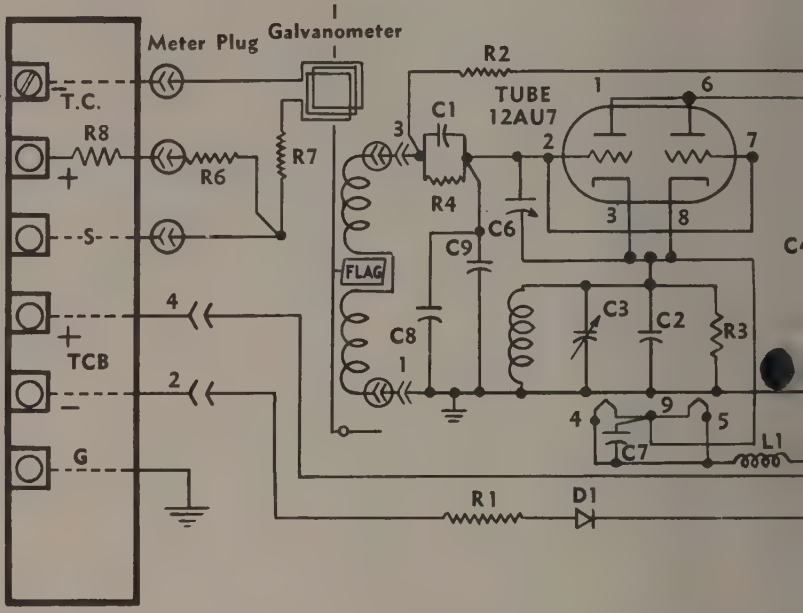
Measurement trouble can be detected by observing the pointer position.

If the measured temperature is known to be in error, check the following:

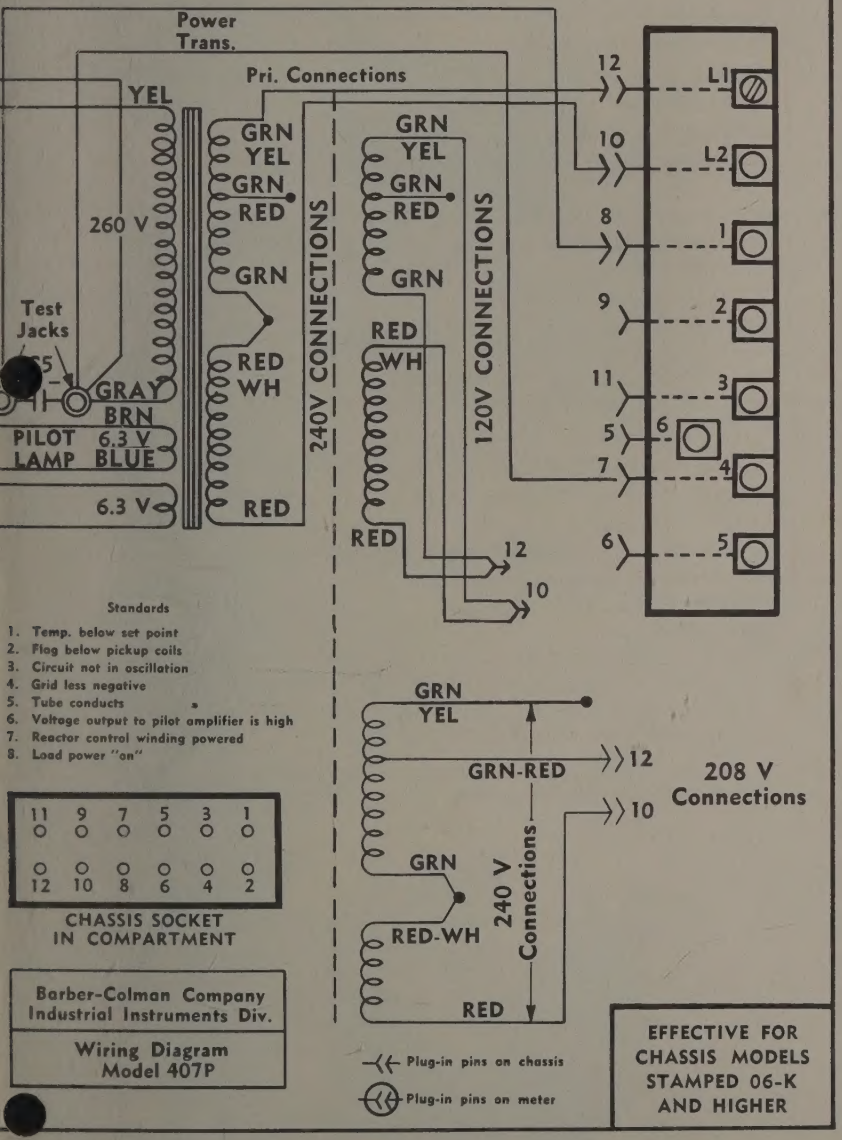
(1) Open thermocouple circuit, such as break in thermocouple or lead wiring.
(2) Deteriorated T.C. hot junction due to burning.
(3) Multiple shorts or grounds creating erroneous cold junctions.
(4) High resistance in leads due to loose connections, dirty switch contacts, poor splicing, and other faulty connections.
(5) Check for vibration or shock.

Control trouble may be detected by observing control point and indicated temperature position. If the temperature is not at the control point check:

(1) Adjust manual reset to align pointers.
(2) Check power input for low maximums if temperature will not rise to control point.
(3) Check power input for high minimums if temperature will not hold to control point. Minimum load voltage, 17% of line voltage.
(4) Is load matched to reactor size?
(5) Determine if instrument and pilot amplifier are powered; check load power for open circuits and open legs in three phase circuits.
(6) Measure output potential at instrument or pilot amplifier input terminals. Check the output of the Model 407P by connecting a DC voltmeter to the red and black jacks on chassis, measuring amplifier output. When the black indicator is well below the red control set pointer, the testmeter should read between 80 and 105 volts DC. When the black indicator is above the red control set pointer, the testmeter should read 10 volts DC or less. Replace tube if above readings are not obtained.
(7) Replace electronic tube.
(8) Replace chassis.
(9) Check for excessive vibrations.
(10) Measure supply for low voltages. Common low voltage to all components will cause large variations in available power to load.



R1	27 K, ± 10%, ½ W	CYZR-170-7
R2	8.2 meg, ± 10%, ½ W	40-089
R3	2.2 K, ± 10%, ½ W	40-062
R4	4.7 meg, ± 10%, ½ W	CYZR-170-18
R6	Range-Multiplier Res. Specify type range and inst. ser. no.	A-1847
R7	Neg. Temp. Coeff. Assy.	A-3049-1
R8	Lead Comp. Res.	A-3041
C1	.02 mfd, 600 VDCW, GMV	39-062
C2	75 mmf, 600 VDCW, NPO	39-125
C3	8-50 mmf variable cap.	39-105
C4	.005 mfd, 1000 VDCW, GMV	39-172
C5	8 mfd, 25.0 VDCW	CYZR-327-1
C6	3-35 mmf variable cap.	39-160
C7	.001 mfd, 600 VDCW, GMV	39-063
C8	12 mmf, ± 5% 500 VDCW, N750	39-107
C9	5 mmf, ± 10%, N470	39-084
L1	Filament Choke	41-124
D1	Selenium Rectifier	37-009


Power
Trans.
Pri. Connections
YEL
260 V
GRN
YEL
GRN
RED
GRN
RED
WH
6.3 V
RED
240V CONNECTIONS
120V CONNECTIONS
Test
Jacks
GRAY
BRN
PILOT
LAMP
6.3 V
BLUE
12
10
8
9
11
5
7
6
L1
L2
1
2
3
4
5
6
Standards
1. Temp. below set point
2. Flag below pickup coils
3. Circuit not in oscillation
4. Grid less negative
5. Tube conducts
6. Voltage output to pilot amplifier is high
7. Reactor control winding powered
8. Load power "on"
11 9 7 5 3 1
12 10 8 6 4 2
CHASSIS SOCKET
IN COMPARTMENT
GRN
YEL
GRN-RED
GRN
RED-WH
RED
240 V
Connections
208 V
Connections
Plug-in pins on chassis
Plug-in pins on meter
Barber-Colman Company
Industrial Instruments Div.
Wiring Diagram
Model 407P
EFFECTIVE FOR
CHASSIS MODELS
STAMPED 06-K
AND HIGHER

In event it is found necessary to remove the meter assembly, follow steps below. This is a plug-in assembly.

(1) Remove set point adjustment knob (Bristol No. 6 wrench).

(2) Remove four cover screws.

(3) Remove cover straight forward to prevent damage to internal meter parts.

(4) Loosen screws in lower meter chassis corners.

(5) Insert fingers behind pulling lugs and pull very gently.

Reassembly is of reverse procedure being careful to line up the slotted lever for the zero adjustment pin when installing gasketed cover. Re-install set point knob.

It is recommended that a few spare sparts be carried by the user to insure against possible emergencies and accidental damage. We do not recommend electronic component replacement except by well equipped instrument repair shops. The following parts are recommended to be carried:

*1—Electronic tube (12AU7) ..... Part No. EYZP-70-9

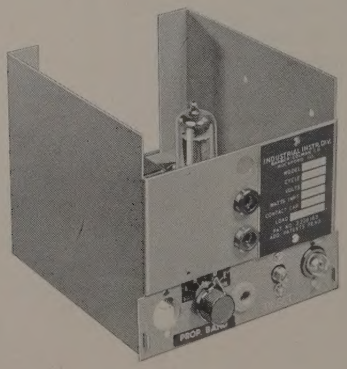
1—Mazda pilot lamp (#51 blue bead) ..... Part No. 36-022

1—Model 407P control chassis ..... Part No. A-3619-1
specify by instrument serial number and voltage.

1—Replacement thermocouple
(See original order)

*NOTE: It is recommended to purchase the 12AU7 tube from the Industrial Instruments Division, Barber-Colman Company to ensure instrument functioning as designed. Tubes are purchased under rigid specifications.

A more rugged industrial tube is available which has a normal life in excess of 10,000 hours. Order tube No. 5814.



MATERIAL WARRANTY: All equipment except tubes, photocells, and thermocouples, which within one year from date of shipment is found to have been originally defective, will be repaired (replaced if necessary) free of charge, if returned immediately, prepaid to the factory at Rockford, Illinois. The seller shall not be liable to the purchaser, or to any other person, firm or corporation for any direct, indirect or consequential damages or injury of any kind or character; that by acceptance of such equipment the purchaser shall accept and assume all liability for any and all damages or injuries that may result from the use or misuse of such equipment by the purchaser, or by any other person, firm or corporation; and that there shall be no other warranty whatever, expressed or implied, with respect to such equipment.

Warranty and Inspection Card

This equipment is guaranteed in accordance with the statement of warranty appearing on our quotation and acknowledgement forms. Upon receipt of this card properly filled out Warranty becomes effective. All Barber-Colman instruments are manufactured to the highest standards of quality and are carefully inspected before packing. Instruments which have been damaged or fail to operate upon installation, should be reported to the Factory at once.

BARBER-COLMAN COMPANY
Industrial Instruments Division

MODEL NO.
SERIAL NO.
CALIBRATION INSP.
FINAL INSPECTION

Date Received		
Company		
Street		
City	Zone	State
By		Title

COMMENTS

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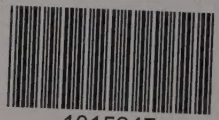

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